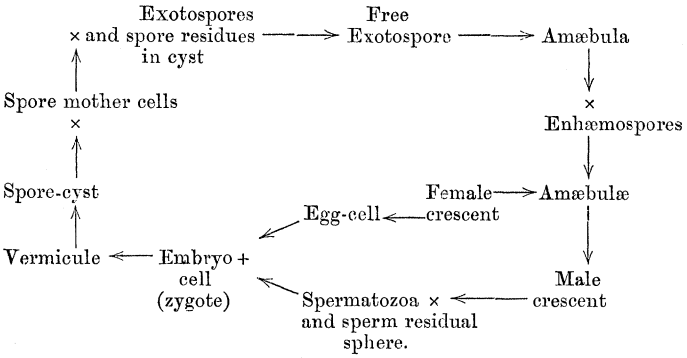
written as below. The sign × is used to indicate fissile multiplication, and + to indicate fusion, while → merely indicates continuity.



I also give a list of the names here used with reference to the occurrence of the forms indicated in man or in gnat and an indication of the corresponding stages in a Gregarina and a Coccidium. In the column belonging to coccidium I have employed the generalised physiological nomenclature accepted by special students of the Sporozoa (Schaudin, Lühe, &c.)

THE CROONIAN LECTURE.—"On Certain Chemical and Physical Properties of Hæmoglobin." By ARTHUR GAMGEE, M.D., F.R.S., Emeritus Professor of Physiology in the Owens College. Lecture delivered March 13, 1902,

(Abstract.)

This lecture consists of two parts, of which the first is bibliographical and critical, the second experimental.

PART I.—*Bibliographical and Critical.*

The author commences by stating that a peculiar interest—the parallel of that which in the plant organism belongs to chlorophyll—attaches to hæmoglobin, for, unlike any other chemical component of the animal body, in virtue of its special chemical and physical attributes, this remarkable substance may in the strictest sense be said to possess a definite and unique physiological function.

The author then discusses certain facts in reference to hæmoglobin and its products of decomposition which have a close bearing on his researches, or which possess special interest in the light of work which

has been recently done. He does so under the following heads :—(1.) The question of the identity of hæmoglobin throughout the animal kingdom, (2.) The nature of the albuminous body which is linked to the coloured iron-containing group in hæmoglobin—*Globin* (*Hæmato Histon*). Under this heading he discusses the general properties of the histons and their relation to the simplest of all the albuminous bodies, the *Protamines*. (3.) The products of the decomposition of the iron-containing molecular group in hæmoglobin. Under this heading the author directs special attention to the researches of Schunck and Marchlewski, which have shown by the oxidation of phyllotaonin, one of the decomposition products of chlorophyll, a substance, PHYLLOPORPHYRIN, is obtained which is probably identical with hæmatoporphyrin. Under this, as also under the preceding head, the author discusses various questions in reference to the seat of the synthesis of hæmoglobin.

PART II.—*Experimental.*

(1.) *Extension of Previous Observations on the Absorption of the Ultra-violet Rays of the Solar Spectrum by Hæmoglobin.*

The author refers briefly (illustrating his remarks by demonstrations) to his researches, previously published, into the absorption of the extreme violet and ultra-violet rays of the solar spectrum by hæmoglobin, its compounds, and certain of its derivatives. The region of the solar spectrum which he formerly investigated was that comprised between the lines F and Q (4861—3280).

He now examines the question whether oxy-hæmoglobin presents definite absorption for light of shorter wave-lengths. Soret, whose observations were not conducted with solutions of hæmoglobin but merely with diluted blood, observing by the aid of his fluorescent eye-piece the cadmium spark spectrum, found that diluted blood, in addition to the absorption band in the extreme violet, exhibited two additional bands. One of these, coinciding with the 12th cadmium line (3247), he considered to be probably due to hæmoglobin; the other, coinciding with the 17th cadmium line (2743), he assumed to be caused by serum albumin, his observations having previously shown that all albuminous and albuminoid bodies, with the exception of gelatin, are characterised by an absorption band in the position of the 17th cadmium line.

Employing solutions of many times crystallised oxy-hæmoglobin of great purity and of varying concentration, and with the aid of the sparks of a powerful induction coil, the author has obtained a series of photographs of the cadmium spark spectrum with and without the interposition of the solutions. The examination of these photographs shows that solutions of oxy-hæmoglobin which are sufficiently trans-

parent to allow the ultra-violet spectrum of cadmium to be photographed, present no absorption bands corresponding either to the 14th or the 17th cadmium lines. The absorption band observed by Soret in correspondence with line 14 is, therefore, not due to the blood colouring matter, but to some other organic constituent present in the blood.

(2.) *Behaviour of Oxy-hæmoglobin and CO-hæmoglobin in the Magnetic Field. The Intense Ferro-magnetic Properties of Hæmatin and Hæmin.*

Having referred to his researches communicated to the Royal Society, in June, 1901, and illustrated the main facts by actual demonstrations, the author discusses (1) observations on the influence of temperature on the behaviour of oxy-hæmoglobin in the magnetic field: (2) observations on the ferro-magnetism of the ferro-albuminates.

(3.) *The Specific Conductivity of Solutions of Oxy-hæmoglobin.*

The author next examines the question of the specific conductivity of solutions of pure oxy-hæmoglobin.

In this research he has worked exclusively with the hæmoglobin of the horse, and, following substantially the method of preparation which in Zinoffsky's well-known investigation yielded the purest product, he succeeded in obtaining crystallised oxy-hæmoglobin of remarkable purity, the ash of which consisted solely of oxide of iron with an indeterminable trace of P_2O_5 and contained no trace of chlorine. He employed oxy-hæmoglobin three times recrystallised, and in addition to the thorough washing by decantation with 20 per cent. alcohol after each successive crystallisation, he treated the ultimate product many successive times with large quantities of pure distilled water having a conductivity which never exceeded $10^{-6} \times 2{\cdot}5$, the washed hæmoglobin being separated by the aid of the centrifuge. The solutions which formed the subject of investigation were made by dissolving the mass of moist hæmoglobin crystals in pure distilled water of 35° C., and cooling the solution thus obtained as rapidly as possible.

In his determination of specific conductivities, the author employed the method of Kohlrausch. The bridge was Kohlrausch's metre bridge, of which the platinum-iridium wire was 3 m. in length. This bridge is furnished with resistances of 1, 10, 100, and 1000 ohms, the precision of which had been kindly determined some years ago for the author by Dr. Glazebrook, F.R.S. The resistance vessels employed were those known after the name of Arrhenius, and the temperature was kept constant by immersing them in one of Ostwald's thermostats furnished with a windmill stirrer.

After a laborious investigation on this branch of the subject, the author has arrived at the following conclusions :—

(1.) Although solutions of oxy-hæmoglobin possess a low conductivity, this is very much higher than has been found in the previous observations of Stewart, all of which were made at 5° C.

(2.) The conductivity of solutions of oxy-hæmoglobin increases rapidly with increase of temperature, and undergoes remarkable and permanent changes when the solution is kept for even short periods at any temperature above 0° C.

These results explain the impossibility of obtaining data which can be considered reliable concerning the *absolute specific resistance* of solutions of oxy-hæmoglobin.

The following numbers expressed in reciprocal ohms represent the mean of the author's results on the specific conductivity of solutions of oxy-hæmoglobin :—

	1. Contains 3·07 per cent. of O_2Hb (or 1 gramme molecule in 542900 grammes).	2. Contains 2·235 per cent. of O_2Hb (or 1 gramme molecule in 745800 grammes).
T.	Conductivity.	Conductivity.
0°	$10^{-5} \times 2{\cdot}626$	$10^{-5} \times 2{\cdot}23$
18°	$10^{-5} \times 4{\cdot}432$	$10^{-5} \times 3{\cdot}25$
25°	$10^{-5} \times 5{\cdot}19$	$10^{-5} \times 4{\cdot}27$
39°	.. ..	$10^{-5} \times 7{\cdot}47$

4. *The Results of the Electrolysis of Oxy-hæmoglobin.*

1. Continuing the researches contained in his first communication to the Royal Society on this subject, the author finds that when pure solutions of oxy-hæmoglobin are subjected to electrolysis, there occurs a separation of oxy-hæmoglobin in a colloidal, but perfectly soluble form. He has worked with currents of from 12 to 24 volts, and the intensity of the electrolysing current measured by a milliampere-meter placed in the circuit has varied in different experiments between 0·1 and 3·0 milliamperes.

2. By employing an electrolytic cell in which the anode is separated from the kathode by an animal membrane (sheep's intestine or pig's bladder), it is seen that the first action of the current is to cause a separation of colloidal hæmoglobin in the anode cell. This colloidal hæmoglobin falls as a beautiful red cloud, leaving a perfectly colourless, supernatant liquid. On stirring it instantly dissolves.

3 The further action of the current is to cause a rapid and entire transfer of the colloidal hæmoglobin from the anode to the kathode cell. With an electrolytic cell, of which each compartment had a

width of 5 mm. and contained 2·5 c.c. of a 1 per cent. solution of O_2Hb, complete precipitation and transfer occurs within 60 minutes.

4. On reversing the direction of the current by means of a commutator, the hæmoglobin returns again in the direction of the positive current into the original cell from which it started.

5. The author adduces evidence which proves that the precipitated colloidal, but yet perfectly soluble, hæmoglobin represents the undecomposed molecule of the blood colouring matter.

6. The probable nature of the process which occurs under the influence of the current is discussed, as well as the character of the process which leads to the transfer of the hæmoglobin in the direction of the positive current. This process the author considers to be of the same nature as the phenomena studied by Quincke under the name of electro-endosmose.

7. The author directs special attention to the importance of the facts which he has elicited in reference to the colloidal yet soluble form of oxy-hæmoglobin. He points out that all which has been said with regard to oxy-hæmoglobin applies to CO-hæmoglobin.

A typical colloid in the sense of its absolute indiffusibility through animal membranes and parchment paper, oxy-hæmoglobin differs, however, from most colloids in the facility with which it crystallises. Hitherto we have known it in its crystalline condition and in solution in water. Now in its third or colloidal form the analogy with such a colloid as silicic acid is rendered complete.

The discovery of this form of hæmoglobin enables us to form a conception of the state in which the blood colouring matter is probably contained in the blood corpuscles. We have known that the amount of hæmoglobin contained in the corpuscles is so large that in most animals at least the whole of the water of the blood would not be sufficient to dissolve it. It was perfectly obvious, therefore, that it did not exist in the corpuscles in a state of solution, and the opinion has generally been held that these contained some unknown compound of oxy-hæmoglobin with a constituent of the stroma. It seems highly probable that in the red blood corpuscle hæmoglobin may be merely present in its colloidal form.

Finally the auther points out that the remarkable facility with which the new colloidal form of hæmoglobin traverses such permeable membranes as the animal membranes and even parchment paper, when its solutions are subjected to electrolysis, suggests to physiologists the possibility that certain of the phenomena of absorption in the animal body may be closely connected with electromotive changes in the tissues concerned.